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The Causes of "Frogging" and "Bloating" of Prunes.

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FIG. 1.

Three large prunes showing proper checking of the skin after dipping.
Three small prunes subjected to the same treatment, but unchecked.

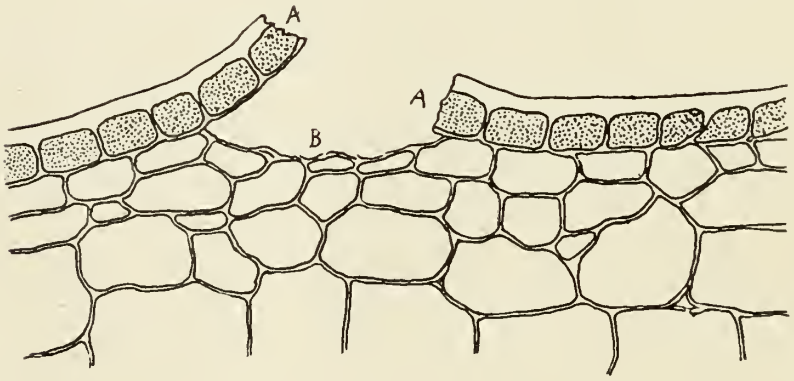

FIG. 2.

Section through the slit of a properly checked prune (enlarged about 200 diameters).
A. A.—Ends of the ruptured epidermis. B.—Unbroken cells of the flesh.

THE CAUSES OF "FROGGING" AND "BLOATING" OF PRUNES.

By F. T. Bioletti.

During the season of 1895 numerous demands were made on the Agricultural Experiment Station for information concerning the so-called "frogging" and "bloating" of prunes. There was evidently wide diversity of opinion as to the cause, nature, and best methods of avoiding these troubles. Under the direction, therefore, of Prof. E. W. Hilgard, I visited several drying establishments in the Santa Clara Valley, in order to examine into the trouble on the spot.

As the claim was made that "frogging" and "bloating" were directly attributable to the practice of lye-dipping, or at least that the pricking process prevented these evils, both processes were investigated. As representative of the lye-dipping process, the West Side Drying Establishment was visited at the instance of Mr. S. P. Sanders. From direct personal observation and from the reports of those engaged in drying the prunes, the following facts were obtained:

The prunes, before drying, pass through a nearly boiling solution of lye, and then through water. A sample of the lye solution taken from the trough as the prunes were passing through, showed 1.6% of alkali. Most of the prunes as they come from the lye are covered with minute cracks or "checks." Some are acted upon too energetically, and come out quite denuded of their skin. For others the treatment is apparently too mild and fails to break the skin at all.

It is prunes of this last class, coming from the process looking smooth and unchanged, that result in frogs. The properly "checked" prunes begin to dry immediately, the skin wrinkling in minute folds. The flesh remains of a light, bright amber color, and the outside of a clear purplish-brown, differing from the shiny black of the pricked fruit. The over-treated prunes simply dry up too quickly and become hard and too dry. The prunes with smooth, "unchecked" skin do not show signs of drying immediately, but remain smooth and round for several days, till they become a dirty brown and the flesh becomes discolored.

When the good prunes are dry the frogs are picked out by hand, put on separate trays, and dried for several days longer. When dry the frogs are smaller than most of the good prunes, of a duller color, and have a less finely wrinkled skin. The appearance of the skin is similar to that of the pricked prunes with regard to smoothness, but they have not the bright black color of the latter. When the frogs are dry they are thrown in with the rest of the prunes; but being mostly small, they are separated by the grader and fall into the lowest grade. The usual proportion of frogs is said not to exceed, on the average, one per cent. One year, certain orchards will produce the largest proportion of frogs, another year others will do so. In general, it is the orchards producing the largest crops that produce the largest percentage of frogs. In the

best drying weather there are few or no frogs produced, while in damp or cloudy weather the proportion is relatively high. If a tray is shaded for any length of time it will contain a larger number of frogs. Fewer frogs come from those orchards where only the prunes which fall naturally from the trees are picked up than from those where the practice is to shake the trees. The first picking and the last contain the greatest quantity of frogs.

A neighboring drying-yard was examined where the fruit was graded *before* dipping. The result was that among the first and second grades there were scarcely any frogs; but in the third or smallest grade there were a good many.

Orchards which produced practically no frogs this year were visited. The trees were found bearing a rather small crop of very fine, large, and well-ripened prunes. The trees were pruned in such a way that no part of the tree was very close-topped, and no part unduly exposed to the sun; the trees being kept fairly open, so as to allow of bearing wood even in the center. They were pruned back enough to avoid all danger from breaking branches, but not enough to make the trees too dense.

Other orchards which were producing many frogs this year were next examined. The trees were bearing very large crops, and many of them had large branches broken off by the weight of the fruit. The fruit on these broken branches was small and hard, and was not so sweet or so well flavored as that on the rest of the tree.

A drying establishment where a pricking machine was used exclusively was also visited. The prunes while passing over the needles were sprayed with warm water, but no lye was used. In passing over the needles the prunes were pricked on about half their surface; that is, on a central zone, the ends being almost intact. The holes were from one sixteenth to one quarter of an inch apart, and each prune had, besides these holes, from two to about ten little slits made by the needles, to which the proprietor looked principally for the useful effects of the process. A certain amount of juice was lost through these slits, but perhaps not more than is lost from the over-treated fruit in the lye process. The prunes were black and shiny on the outside, of very good appearance, but inside, the flesh was darker-colored than that of the lye-dipped prunes. There were practically no frogs that could be picked out.

OBSERVATIONS IN THE LABORATORY.

On September 12, 1895, samples of *fresh prunes* were received for experiment from Mr. S. P. Sanders, as follows:

1. Prunes that were gathered from branches broken down by the weight of fruit. The fruit was still attached to the branch, though the prunes from the unbroken branches of the same tree had nearly all fallen and been gathered.

2. Prunes from the unbroken branches of the same heavily laden trees as No. 1. The fruit was small, but in good condition.

3. Prunes from trees bearing a moderate crop of fine, well-ripened fruit. All were soft and a few showed signs of commencing to dry.

The prunes (No. 1) from broken branches were treated with a boiling 1.6% lye solution. After 20 seconds immersion only one prune was checked. After 40 seconds some skins were split in consequence of partial cooking, but there were no genuine checks. After 60 seconds the

prunes had suffered from cooking, but were not checked. A 3% boiling lye solution was then tried. Different samples of the prunes were dipped for 5, 10, 20, and for 60 seconds, with practically the same results as with the weaker solution.

Of the prunes (No. 2) from the unbroken branches of heavily laden trees, about half felt soft and half hard. The hard and the soft fruit were treated separately, but with practically the same results; about the same proportion of each failing to check properly. Immersion for 20 seconds in a boiling 6% lye solution checked about half of the prunes well. Most of the rest were checked more or less insufficiently, while a few were not checked at all. These last presented the same characteristics as the fruit from the broken branches, and like them the skin could not be broken short of cooking.

The first-class prunes (No. 3) were tried first with a 1.6% solution. In this strength of solution at the boiling temperature from 20 to 30 seconds was the best time of treatment. More than 40 seconds' immersion completely removed the skin in places. With this strength of lye (1.6%), boiling temperature, and 20 seconds' immersion, all the prunes of this lot checked perfectly. A 3% solution was found too strong, even with only 10 seconds' immersion. A shorter time failed to check the skin, and a longer completely removed it. Experiments at different temperatures showed that if the lye is much below the boiling-point, the skin does not check. If left in the lye longer at these lower temperatures the skin finally cracks like that of the small prunes described above, and instead of innumerable shallow cracks there are a few deep splits.

All the prunes of this series of experiments were placed on trays and put to dry in the sun in as nearly similar conditions as possible to those which obtain in the drying-yards. The results were exactly the same as those noted at the West Side drying-yard. The prunes which had failed to check turned brown and were long in drying; the others dried in a few days. An attempt was made to determine the presence of a mold or other micro-organism within the tissue of the brown prunes, but without success. A determination of the sugar contents in the two kinds of prunes was made by Mr. Colby, with identical results for each kind. Microtomic cross-sections of the skin were made in order to determine if the relative thickness of the epidermis was in any way connected with the failure to check. A slight difference of thickness was found, but not enough to account for the great difference of behavior in dipping. Ten measurements of the thickness of the skin of prunes (No. 1) from broken branches showed an average of 24.9 μ (microns), while the average of eight measurements of the skin of large, well-ripened prunes (No. 3) was 23.6 μ. Under the microscope the walls of the epidermal cells of the small prunes appeared thicker and retained their shape better under the operations of hardening, imbedding, and cutting, showing that they were of a more resistant nature.

The following three samples of *dried prunes* were received later in the season from Mr. S. P. Sanders:

4. *Frogs.* These were small, hard, smooth-skinned prunes of the typical dirty-brown color outside, and dark color inside. They averaged 120 to the pound, and showed 35.25% of sugar. The skin showed no checks. The higher sugar content as compared to No. 5 is to be accounted for by over-drying.

5. *Large prunes* of good quality. Light purplish color outside, with finely wrinkled skin, and bright amber color inside. These averaged 43.2 to the pound, and showed 33.25% of sugar. The skin showed the customary close checking of successfully dipped prunes.

6. *Bloaters.* These prunes were very large, a little darker in color than No. 5, and with equally fine-wrinkled skin. The inside was dark-colored in places, but in general resembled that of the prunes of No. 5 in texture, though a little harder and more thoroughly dried. They were hollow, and in many cases the stone was split. They averaged 37.4 to the pound, and showed 39% of sugar. The skin was finely checked, at least as thoroughly as in No. 5.

"FROGS" AND "BLOATERS."

At the drying-yards which I visited, the terms "frogs," "frogbellies," and "bloaters" seemed to be used indiscriminately. There are, however two things, very distinct both as to cause and effect, confused under these names. The prunes which I will call bloaters, for the sake of distinction, are generally, perhaps always, large prunes, originally. In drying they swell up to half again their natural size, on account of a gas-producing fermentation around the pit. They become hollow and the pit frequently splits in two. In grading, they all fall in with the largest size, and in the after-dipping, owing to the air space within, they float and can be separated. In quality, as far as eating is concerned, they are almost equal to the first-class prunes, but are not so attractive in appearance, on account of their swollen look. The fermentation that they undergo is slight (in the cases that have come under my observation), as is proved by the high percentage of sugar which they contain. This is higher than in the case of the good prunes; a fact which is to be accounted for, partly by their more complete ripeness when gathered, and partly by the greater amount of drying which they undergo on account of the hollow space around the pit. The bloaters are doubtless large, soft, very ripe prunes, which in falling from the tree become injured in such a way as to allow the yeast germs which exist on the skins of all fruits to find entrance, probably at the hole left by the detachment from the stem. The remedy would be, frequent gathering, in order not to allow the yeast to develop in the shade of the trees before the fruit is dipped and placed upon the drying trays. The prunes which have a tendency to become bloaters, being thoroughly ripened, dry quickly; and unless the fermentation has obtained a good start before they are placed upon the drying-trays it will have no chance to develop enough gas during the process of drying to puff them, unless the drying for some reason is slower than usual. Pricking, if it were deep and thorough enough, might allow the gas to escape as given off and thus prevent bloating.

The prunes which I will call "frogs," as distinguished from "bloaters," are of an altogether different character. They are almost always small prunes and imperfectly developed. This failure to develop properly may arise from various causes. It may sometimes be due to unsuitable or poor soil, but in the cases which have come under my observation it is usually due to overbearing. A tree producing too heavy a crop fails to properly mature its fruit; it cannot supply the requisite nourishment and moisture for so large a quantity. The fruit

upon the broken branches is still more insufficiently supplied with the necessary material to complete its development, and it is precisely this fruit which is most prolific in frogs. Fruit which is shaken from the trees is often incompletely developed, and therefore results in many frogs. Trees were observed this year which were prematurely deprived of their leaves by a fungus (*Puccinia pruni-spinosæ*, Pers.). The fruit on these trees was precisely of the character of those which become frogs. In short, anything which prevents the fruit from attaining a normal and complete development and maturity will occasion frogging. The way to prevent their production, therefore, is to keep the trees in perfect order, and allow them to produce only a reasonable crop; to gather the fruit only when it has attained the proper stage of maturity; and to dry as quickly as possible. Prevention is better than cure; but, if prunes are to be dried which have a tendency to frog, I would strongly advise preliminary grading. This is more especially important where the dipping process is in use. The smallest grade will then contain by far the largest part of the prunes liable to frog, and can be treated in a different manner from the good prunes. The extra expense would be more than counterbalanced by the less amount of sorting-over that would have to be done during the process of drying. As lye-dipping has no effect on the frog prunes, they should be pricked, and unless the weather is of the best drying character they should be dried by artificial heat.

In view of the great influence which a proper system of pruning may have in preventing the production of frogs, a series of photographs of prune trees taken by Mr. Sanders is of great interest. These photographs have been kindly donated by Mr. Sanders to the Station, and the most instructive of them will be reproduced in the forthcoming agricultural report.

Judicious pruning prevents the production of frogs by regulating the bearing of the trees, not allowing them to overbear one year at the expense of the next, nor allowing some branches to carry more than their share of the load, and by so regulating and adjusting the branches that they will have the maximum bearing strength; that is, that they will bear as heavy a load as possible without breaking. The system advocated by Mr. Sanders and exemplified in his photographs interferes as little as possible with the natural form of the tree. It simply thins out and directs the growth where necessary. It aims to produce a tree with an upright central trunk, from which the branches grow out alters nately instead of opposite to each other in pairs. It avoids the production of weak crotches, and especially of the forks which are caused by the repeated cutting-back system. These objects are attained by taking the unpruned tree as a model and only cutting where it is necessary to prevent irregularity of growth or of shade, and to distribute the bearing wood as evenly as possible. A tree is thus produced with the maximum breaking strength and one which distributes its energy properly between the production of foliage and fruit and the storage of reserve material. Trees treated in this way do not have to be held together with iron bolts and bands or propped up with wooden crutches. They do not exhaust the reserve materials stored up in their trunks and roots in the production of an immense crop of inferior fruit, nor expend their energies on an unnecessarily large growth of new wood and foliage.

LYE-DIPPING AND PRICKING.

The difference of opinion regarding the relative value of these two processes is so marked, practical men who have investigated and even tried both methods are so diametrically opposed in their views on the subject, that *a priori* there would seem to be but one explanation, viz., that it is largely a matter of taste. As a matter of fact, each process has produced dried prunes of excellent quality, which proves that if the conditions are right either process will produce good results.

The accompanying cut (Fig. 2) may be of some use in explaining the differences of effect between the checks of lye-dipping and the holes and slits made by the needle machines. It represents the microscopic appearance of a cross-section through a check of the proper size. It will be noticed that the skin is simply broken and very little of the flesh of the fruit exposed. A few of the thin-walled cells of the flesh (B) have collapsed, owing to the action of the hot lye, but none of them are broken. The lye check is thus very different from the needle slit, which cuts through several layers of the soft inner cells. This deeper cutting of the flesh would seem at first glance to favor rapid drying. That it does not do so is due, in the first place, to the small number of slits made by even the most efficient machine compared to the number of checks on a successfully dipped prune, and in the second place to the fact that the juice which is allowed to flow out of the cells broken by the needles solidifies and chokes up the slit. When a prune is over-treated by the lye process, the skin (A) rolls back, exposing more of the flesh and in extreme cases completely denuding it.

The advocates of lye-dipping claim:

1. That the prunes are more thoroughly cleansed;
2. That they dry more quickly;
3. That the skin is rendered less tough;
4. That the finished product is of better appearance;
5. That the flavor is better.

On the other hand, the advocates of pricking claim:

1. That the hot water they use cleans the fruit perfectly;
2. That the prunes dry more evenly;
3. That no frogs are produced;
4. That the finished product is of better appearance;
5. That the flavor is better.

With certain reservations and explanations it may be said that all the claims of each side are true. With some pricking machines the washing is not very thorough, but with the best arrangements the cleaning is quite satisfactory. The lye-dipped prunes dry, according to the weather, in from two to seven days less time than the pricked prunes. But the greater uniformity in the drying of the pricked fruit probably quite offsets this, especially where there are many tough-skinned prunes which the lye does not affect.

The third claim of the advocates of lye-dipping, that the skin is rendered less tough, hardly cuts any figure, as the lye acts only on those prunes which have naturally a tender skin, and leaves the tough-skinned ones untouched. It is with regard to the fourth claim, that is, with regard to the appearance of the fruit, that there is most to be said on both sides. All that the unbiased observer can remark is that the

finely wrinkled skin and light amber color of the lye-dipped prunes are very attractive to those whom they attract, while the same remark applies to the smooth, shiny skin and black color of the pricked prunes. As it is a matter of the consumer's taste, the market should quickly settle this question. It may be added that the smooth skin and black color are characteristic of the best French dessert prunes, dried without either lye-dipping or pricking; and as habit is so powerful in matters of taste, this fact will certainly have influence. With regard to flavor my own impression is that the difference is so slight as to be scarcely noticeable, and to be quite obscured by the least diversity in the original quality of the fruit.

The conclusion, therefore, would seem to be that if we are dealing with good raw material, that is, fine, well-ripened prunes and good drying weather, the choice of method must depend on which appearance is most attractive to the average consumer.

There are, however, other cases to be considered. In the case of unevenly developed, mixed lots of fruit the pricking process affords more security against the frogging of a portion of the fruit, and the product is much more uniform in appearance and in time of drying. Uniformity in time of drying is very important, as the difficult and expensive hand-sorting on the drying-trays is thus reduced to a minimum. The mere pricking of a needle-hole evidently facilitates drying but very little; the exuding juice almost immediately closes up these fine holes. It is otherwise with the slits, which, being similar to the effect produced by the lye process, facilitate drying much more. Still the flow of sap consequent on the penetration of the needles into the flesh tends to close up the finer slits also and thus retards drying, while, however, imparting to the surface that shining appearance which the lye-dipped prunes only obtain by an after-treatment.

It thus appears as though both processes had their place in the prune-drying industry, each serving best under special conditions; and that the smaller sizes especially would, on the whole, be more advantageously treated by the pricking than the lye-dipping process.

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